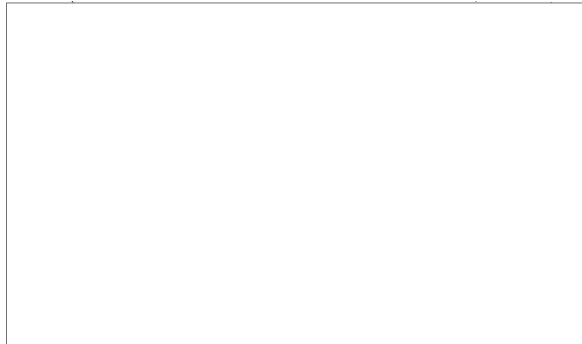


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TESTING AN AUTOMATIC RECORDER FOR OXYGEN MEASUREMENT

A. Splittgerber

Vom Wasser, 12 (1937) 173-176
(From German)

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The readings of the Chlorator Gesellschaft instrument for oxygen (1)* measurement show a very close numerical agreement with the results of the chemical test (mean deviation ± 0 , maximum deviations between 0.02 mg per litre less and 0.03 mg per litre more indicated by the oxygen instrument than found by the chemical method); but this must not be regarded as a proof of special reliability. In actual fact, this agreement is a deviation from the rule - observed hitherto in other power installations and in agreement with theoretical considerations - which requires the readings of the testing apparatus to be, on an average, 0.02 mg per litre higher than the chemical results; this is because up to 0.025 mg per litre of residual oxygen may elude purely chemical tests, owing to the internal consumption of iodine by water (2). This deviation was more probably caused by a reduction in the rate of flow due to partial clogging of the discharge nozzle of the flow indicator and also by an unintentional increase in the temperature of the test-water. After taking these sources of error into account, the reading at the instrument is again 0.02 mg per litre higher, which is in accordance with expectation.

The automatic oxygen recorder made by the Chlorator Gesellschaft operates at a regulated supply pressure of 0.15 atmosphere absolute pressure and is capable of passing in shunt 12 litres per hour of water under test instead of the usual 5 litres per hour. The calibration of the instrument is based on this rate of flow and on a water temperature of 24°C.

The diagram in Figure 1 shows how the instrument is fitted into the water circuit. By this means it is possible to test the water which has been de-gassed in vacuum for oxygen content, either before or after the feed-pump as desired; in the latter case the pressure of the pump has to be suitably reduced.

The small filter which was originally fitted in the apparatus for removing fine impurities from the test-water has now been dispensed with. Instead, regular observation is made through the inspection window and as soon as an electrode begins to get coated the deposit is removed. This cleaning has to be carried out very carefully and promptly as otherwise the subsequent impurity soon causes the instrument reading to be too low, to the extent of 0.03 - 0.04 mg per litre.

TEST

Residual oxygen measurements were made on samples of the degassed water which had passed through the instrument and also on samples which had bypassed the apparatus: the necessary precautions were taken, e.g. use of flasks filled with carbon dioxide, greasing of glass stoppers, dissolving the manganese precipitate in phosphoric acid instead of in hydrochloric acid (2).

The experimental results are represented by the curves in Figure 2 and lead to the following conclusions:

For references, see end.

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- (a) A decision whether the claim made for the degassing plant is substantiated can, in view of the developments be based only on the findings of the chemical test and not on the indications of the oxygen measuring instrument. If all the test values which can be affected in any way by leakage, etc., are excluded, i.e. approximately from 3rd March, 7 p.m. onwards, it can just be established that the limits of the claim have been maintained; taking into account the inevitable experimental errors amounting to 0.02 - 0.03 mg per litre, the chemically determined oxygen content of 0.03 mg per litre must be accepted as fulfilment of the claim.
- (b) In itself the numerical agreement between the readings of the Chlorator instrument and the results of chemical tests seems to be extraordinarily satisfactory; the mean deviation lies exactly at ± 0.00 mg per litre and the maximum deviations between 0.02 mg per litre less and 0.03 mg per litre more recorded by the apparatus than by the chemical method.

Compared with observations already made on other power plants of associated works and in view of theoretical considerations, this represents a slight deviation from the rule: in all the cases so far observed the average reading of the experimental apparatus agreed with the theory, in that it was 0.02 mg per litre higher than the average value obtained by chemical experiment. This must be so, because, owing to the possible internal consumption of iodine by water, up to 0.025 mg per litre of oxygen may elude purely chemical investigation (2).

In the present case, this deviation may be explained partly by the observations made during the experiment - and reported later - that the specified flow of 12 litres per hour was not achieved until after the partly clogged discharge nozzle of the flow indicator on the oxygen measuring instrument had been cleaned. It is known that, for a given oxygen content, a reduction of the quantity of flow by 1 litre brings the indicator reading down by 3.5 graduations from 30 to 26.5. Thus, for example, with an indicator reading of 0.10 mg per litre, if the flow is reduced by 1 litre owing to clogging, the reading would rise to 0.113 mg per litre when the restriction in the flow was removed. Conversely, an increase in the indicator from 0.07 to 0.12 mg per litre residual oxygen content, observed after cleaning, would indicate that there had been a reduction in the flow from 12 litres to 7 litres.

Since it is not mentioned in the working report, it must be assumed that, after cleaning the discharge nozzle, care was not taken to allow for the increased flow and to arrange at once for extra cooling water in order to achieve the same temperature (24°); thus it is possible that the water passing through the apparatus was 24° too high. It is known, however, that an increase in temperature of 1° raises the indicator reading - at 30 graduations - by 1 graduation. Thus, if there were a noticeable increase in the temperature of the water after the cleaning process, it might be that the actually observed difference in the reading, from 0.07 to 0.12 mg per litre occurring after cleaning, would be attributable only in part to the increased flow, the remainder being due to the heating which had taken place. After the specified temperature had been adjusted the difference should have been not 0.05 mg per litre but less. This would have given the slightly higher reading, as compared with the chemical tests, which had been observed previously at other works and which is supported by theory.

About 12 hours after cleaning the discharge nozzle there is a definite reversal of the relation between the position of the indicator of the experimental apparatus and the results of the chemical test; from 4.30 p.m. on 4th March the chemical result was again 0.01 to 0.02 mg per litre higher than the instrument reading. This reversal, which is again a deviation from the rule, can perhaps be ascribed to impurities as a result of which the indication may lag behind the actual content by 0.03 - 0.04 mg per litre.

From the left hand part of Figure 2 (lower half) it seems possible to draw the surprising conclusion that although there is continuous boiling (upper half), degassing was more favourable with a falling vacuum or increasing temperature. This conclusion is really false, however, as can be seen by a glance at the right hand section of the curves for 4th March; it is explained, apparently, simply by the fact that, owing to the several leaks which occurred during that time, there was more atmospheric oxygen drawn in and not completely eliminated in proportion to the increase in the vacuum or the decrease in the temperature.

REFERENCES

- (1) See "Vom Wasser" 2, II (1934) 183-185, 12 (1937) 168.
- (2) See Splittgerber: Boiler feed water maintenance. Akadem. Verlagsges., Leipzig 1936, page 161.

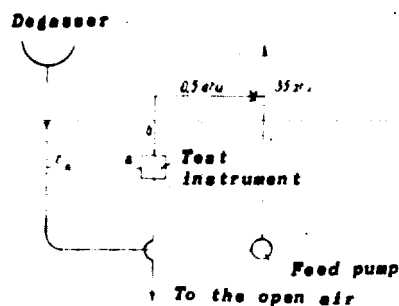


Fig.1: Insertion of the oxygen measuring apparatus in the water circuit.

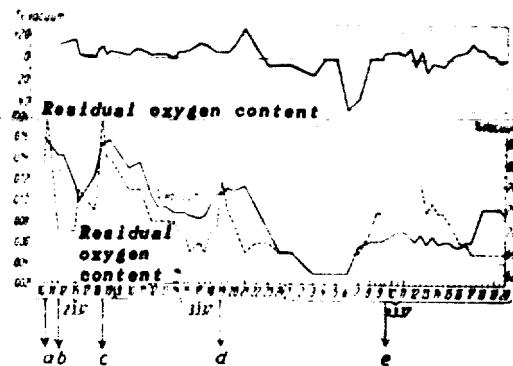


Fig.2: Experimental results.

Above: Amount in excess (+) and deficit (-) of theoretical vacuum
Below: Relation between vacuum and residual oxygen content

- a) Establishment of fact that air had reached degassing system due to the exhaust pipe of a turbine-driven transfer pump not being completely closed.
- b) After the leak had been discovered.
- c) Oxygen testing apparatus disconnected and examined for leaks.
- d) Cleaning of the discharge nozzle of the flow indicator on the apparatus.
- e) Oxygen testing apparatus used to examine the feed water in the delivery pipe.